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Evaluation of Particle-In-Cell simulation by experiments in a small hydrogen negative ion source

Yoshikatsu Matsumoto[1], Masashi Kisaki[2], Masaki Nishiura[3], Hitoshi Yamaoka[4], Mamiko Sasao[5], and Motoi Wada[5]

[1]*Tokushima Bunri University, Tokushima, Japan*
[2]*National Instruments for Fusion Science, Toki, Gifu, Japan*
[3]*The University of Tokyo, Kashiwa, Chiba, Japan*
[4]*RIKEN SPring-8 Center, Sayo, Hygo, Japan*
[5]*Doshisha University, Kyotanabe, Kyoto, Japan*

Corresponding Author : Yoshikatsu Matsumoto, E-mail adderss: ymatsumoto@tokushima.bunri-u.ac.jp

Development of highly efficient negative hydrogen (H^-) ion sources require precise study on ion production and extraction. Numerical simulations by Particle-In-Cell (PIC) method have largely contributed to qualitatively understand how relevant fundamental processes affect the final intensity of the extracted beam. However, to improve the method further to make the result more reliable, PIC simulation should be compared to experimental results in detail.

In this study, we simulate hydrogen negative ion source plasma operated without cesium by a 2D3V PIC code. We evaluate the simulation results by comparing them to the experimentally measured plasma parameters by Langmuir probes in a small ion source depending upon beam extraction voltage [1]. We take spatial distribution of magnetic field intensity and configuration of electrodes of our experimental system into account the code so that simulates the condition identical to the actual operation. A spatial profile of electron density assuming collisionless plasma shows a large discrepancy to the experimental one. It may imply that PIC method in the assumption cannot correctly simulate electron transports across filter magnetic field in extraction region.

[1] Y. Matsumoto, M. Nishiura, H. Yamaoka, M. Sasao, and M. Wada, Rev. Sci. Instrum. **85**, 02A720 (2014).